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S I R:

Transmitted herewith for filing is: ☒ a new application
☐ a c-i-p application of S.N. _____ filed _____

Inventor(s): Shigefumi MASUDA; Minoru ISHIDA

For: DEVICE AND SYSTEM FOR REDUCING CONFLUENCE NOISE

Enclosed are:

- ☒ 14 sheets of drawings.(Figs. 1-14)
☒ Specification, including claims and abstract (34 pages)
☒ Declaration
☒ An assignment of the Invention to FUJITSU LIMITED
☒ A certified copy of Japanese Application No(s). 11-159439
☒ An associate power of attorney
☐ A verified statement to establish small entity status under 37 CFR 1.9 and 37 CFR 1.27
☒ Post card
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☐ Information Disclosure Statement, PTO-1449, copies of ____ references
☐ Other _____
☐ Other _____

	Col. 1	Col. 2
FOR:	NO. FILED	NO. EXTRA
BASIC FEE		
TOTAL CLAIMS	15-20 =	0
INDEP CLAIMS	2-3 =	0
<input type="checkbox"/> MULTIPLE DEPENDENT CLAIMS PRESENTED		

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RATE	FEE
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x 9 =	\$
X 39 =	\$
x 130 =	\$
TOTAL	\$

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x 18 =	\$
x 78 =	\$
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SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT WE, Shigefumi Masuda, a citizen of Japan residing at Kawasaki-shi, Kanagawa, Japan and Minoru Ishida, a citizen of Japan residing at Kawasaki-shi, Kanagawa, Japan have invented certain new and useful improvements in

DEVICE AND SYSTEM FOR REDUCING CONFLUENCE NOISE

of which the following is a specification : -

DEVICE AND SYSTEM FOR REDUCING CONFLUENCE
NOISE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a system and a device for reducing confluence noise which are used in a two-way CATV (cable television) system.

2. Description of the Related Art

A two-way CATV system uses a certain frequency band for downward signals directed from a center (headend) to terminals (users), and uses a different frequency band for upward signals directed from terminals to the center. These signals are transmitted through coaxial cables or optical fiber cables to achieve two-way communication. In this configuration, upward signals are mixed with noises as these signals travel to the center. Such noises are called confluence noise, and measures for reducing the confluence noise need to be devised.

Fig.14 is an illustrative drawing showing a related-art CATV system.

The CATV system of Fig.14 includes a center 201, a two-way amplifier 202, splitters 203, and terminals 204. The center 201, the two-way amplifier 202, and the splitters 203 are connected via a main transmission line. A plurality of two-way amplifiers 202 are generally provided at predetermined intervals along the main transmission line, thereby amplifying upward and downward signals transmitted through the main transmission line. The splitter 203 may be implemented by using 8 branching configuration. Branch transmission lines connect between the splitters 203 and the terminals 204.

Upward signals from the terminals 204 to the center 201 may be carried through a frequency band with

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when a user moves out, for example, the branch transmission line ends up having an open end. The open end serves as a noise source by generating reflection noises, so that noises without signals may enter a splitter 203 via the branch transmission line. In other cases, upward signals may include large noises because of malfunction of the terminals 204. In such cases, the terminals 204 act as noise sources. When a plurality of noise sources are present, generated noises are summed at the splitters 203, thereby significantly reducing the C/N of the upward signals. In the worst case, the center 201 cannot detect received signals, resulting in a system shutdown.

Accordingly, there is a need for a scheme which can reduce confluence noise.

SUMMARY OF THE INVENTION

Accordingly, it is a general object of the present invention to provide a scheme which can satisfy the need described above.

It is another and more specific object of the present invention to provide a scheme which can reduce confluence noise.

In order to achieve the above objects according to the present invention, a system for reducing noise in a signal line, through which upward signals and downward signals are transmitted between a center and terminals, includes a noise-reduction device provided between the center and the terminals. The noise-reduction device attenuates the upward signals by an increased amount when a noise increase regarding the upward signals is detected on the signal line. The system further includes a noise-control device, provided at terminals, which boosts a transmission level of the upward signals by an amount compensating for the attenuation of the upward signals by the noise-reduction device.

In the system described above, the upward signals having the boosted transmission level are attenuated by the noise-reduction device to return to their original transmission level. As the upward signals are attenuated, noises are attenuated along with the upward signals, so that a C/N ratio of the upward signals can avoid degradation caused by the noise increase.

Other objects and further features of the present invention will be apparent from the following detailed description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig.1 is a block diagram of a confluence-noise-level-check unit used in a confluence-noise reduction device according to a first embodiment of the present invention;

Fig.2 is a block diagram of a confluence-noise-reduction unit used in the confluence-noise-reduction device according to the first embodiment of the present invention;

Fig.3 is an illustrative drawing showing an embodiment of a confluence-noise-reduction system according to the present invention;

Fig.4 is a block diagram of a relevant part of a terminal used in the confluence-noise-reduction system according to the present invention;

Fig.5 is a block diagram of a confluence-noise-level-check unit used in a confluence-noise reduction device according to a second embodiment of the present invention;

Fig.6 is a block diagram of a confluence-noise-level-check unit used in a confluence-noise reduction device according to a third embodiment of the present invention;

Fig.7 is an illustrative drawing for

Fig.8 is an illustrative drawing for explaining the level-check operation of the present invention;

Fig.10 is a block diagram of an upward-signal-attenuation unit used in a confluence-noise-reduction system according to another embodiment of the present invention;

Fig.12 is an illustrative drawing of a confluence-noise-reduction system according to another embodiment of the present invention;

Fig.14 is an illustrative drawing showing a related-art CATV system.

In the following, embodiments of the present invention will be described with reference to the accompanying drawings.

The confluence-noise-level-check unit of Fig.1 includes a band-pass-filter/buffer-amplifier unit 1, a demodulator 2, a band-pass filter 3, a high-frequency switch circuit 4, a level-check unit 5, an average-demodulation-level-storage unit 6, a noise-

A confluence-noise-reduction device is generally situated where splitters or two-way amplifiers are provided along upward-signal transmission lines. The confluence-noise-level-check unit of such a confluence-noise-reduction device detects a situation where a confluence-noise level exceeds a predetermined threshold. The band-pass-filter/buffer-amplifier unit 1 has such frequency characteristics that only the upward signals having a frequency band between 10 MHz and 55 MHz can pass through. The band-pass-filter/buffer-amplifier unit 1 is used for extracting the upward signals being transmitted through the main or branch transmission lines by using a buffer amplifier having a high-input impedance.

The demodulator 2 is configured in accordance with an employed modulation scheme such as BPSK, QPSK, or QAM. For example, the demodulator 2 may reproduce a carrier wave from a received high-frequency signal by using a proper reproduction scheme, and may use the reproduced carrier wave to carry out coherent detection of the received high-frequency signal. Alternatively, the demodulator 2 may delay a received high-frequency signal by one symbol, and may use the delayed signal to perform coherent detection of the received high-frequency signal. In such cases, a preamble obtained as a burst signal exhibits a predetermined pattern. When an output signal obtained through the coherent detection shows this predetermined pattern, therefore, the upward signal may be regarded as a valid upward

signal. Here, the demodulator 2 may have a simpler configuration when the configuration based on the delayed signal is employed than when the configuration based on the reproduced carrier wave is employed. Use of such a simpler configuration can economize the system.

The band-pass filter 3 is designed to allow passage of a base-band signal, i.e., passage of a demodulated signal output from the demodulator 2. For example, the band-pass filter 3 may have a pass band between 10 kHz and 10 MHz. In consideration of the fact that upward signals are transmitted as burst signals, the average-demodulation-level-storage unit 6 holds an average level of the base-band signal supplied from the demodulator 2 where the average is obtained over a predetermined time period. Alternatively, the average-demodulation-level-storage unit 6 may hold therein a reference level for a comparison check.

The level-check unit 5 compares a level of the base-band signal supplied from the demodulator 2 with a level held by the average-demodulation-level-storage unit 6. In general, a signal level is greater than a noise level. When the base-band-signal level is close to the average level of the detected signal or exceeds the reference level, a received signal is ascertained as a valid upward signal. In this case, the level-check unit 5 supplies a control signal to the high-frequency switch circuit 4 to switch it off.

When the base-band-signal level is lower than the level of the average-demodulation-level-storage unit 6 by a significant margin, the level-check unit 5 ascertains that the received signal is not a valid upward signal. In this case, the level-check unit 5 supplies a control signal to the high-frequency switch circuit 4 to switch it on. The upward signal from the band-pass-filter/buffer-amplifier unit 1 is thus supplied to the noise-detection unit 7 via the high-

frequency switch circuit 4.

The noise-detection unit 7 may be configured to detect an envelop of a noise after converting it into medium-frequency signal. Further, since an upward signal is a burst-like signal, the noise-detection unit 7 can be configured to hold a noise level that is detected during a period when no valid upward signal is transmitted. The noise-level-check unit 8 compares a level of an output of the noise-detection unit 7 with the level or reference level held by the average-demodulation-level-storage unit 6. When the level of the output of the noise-detection unit 7 exceeds the level or reference level of the average-demodulation-level-storage unit 6, the noise-level-check unit 8 ascertains that there is an increase in confluence noise, and supplies a control signal to the noise-reduction-control unit 9.

Since only noises are present during a time period between a burst-like signal and a next burst-like signal, the noise-detection unit 7 can detect a noise level of such noises. The detected noise level is compared with the signal level or a predetermined level. If the noise level is greater in comparison, it is ascertained that the level of confluence noise has increased. Here, the output level of the noise-detection unit 7 can be compared with the reference level. In consideration of possible changes in transmission conditions, however, use of the level of a detected signal or an average thereof may be preferred over use of the fixed reference level since such a detected signal follows the changes of the transmission conditions. This can improve accuracy of the noise detection. Further, a ratio of comparison may be set in the noise-level-check unit 8 in advance.

Based on a result of the check made by the noise-level-check unit 8, the noise-reduction-control unit 9 may supply an alarm signal, or may activate a

In the configuration described above, the level-check unit 5, the average-demodulation-level-storage unit 6, the noise-level-check unit 8, and the noise-reduction-control unit 9 may be implemented by using digital circuits. Alternatively, functions of these units may be implemented via a processor performing equivalent functions.

Fig.2 is a block diagram of the confluence-noise-reduction unit used in the confluence-noise-reduction device according to the first embodiment of the present invention.

Downward signals from the center to the

terminals travel through the high-pass filter 11, the amplifier 13, and the high-pass filter 17 before they reach the terminals. As this happens, the band-pass filter 15 extracts a pilot signal. In response to the control signal supplied from the confluence-noise-level-check unit 20, the modulation unit 16 modulates a tone signal, and inserts the tone signal into the pilot signal before transmitting the pilot signal.

Upward signals are transmitted to the center via the low-pass filter 19, the variable attenuator 18, the amplifier 14, and the low-pass filter 12. The variable attenuator 18 can be implemented by using a known structure, and is used for controlling attenuation of the upward signals.

The confluence-noise-level-check unit 20 has the same structure as that shown in Fig.1. The control signal supplied from the noise-reduction-control unit 9 as a result of the noise-level check is supplied to the variable attenuator 18 and the modulation unit 16. When there is an increase in confluence noise, the control signal from the confluence-noise-level-check unit 20 prompts the modulation unit 16 to modulate the tone signal and insert it into a downward signal. The tone signal makes amplifiers increase gains thereof where the amplifiers are situated at cable modems or the like in the terminals. As a result of the gain increases, transmission levels of upward signals are boosted. At the same time, attenuation of the variable attenuator 18 is controlled to attend to stronger attenuation of the upward signals having the boosted transmission levels.

As previously described, upward signals merge at the splitters, and noises are summed together as they come from noise sources such as an open end of a branch transmission line. This results in a rise in a confluence noise level. In the present invention,

Fig.3 is an illustrative drawing showing an embodiment of a confluence-noise-reduction system according to the present invention.

The confluence-noise-reduction device 25 may be provided in at least one of the two-way amplification unit 21 and the splitter units 22, which are situated at predetermined intervals along the main transmission line 30. In Fig.3, one confluence-noise-reduction device 25 is provided for each of the terminals 23. Instead of such a configuration, it is acceptable to provide one confluence-noise-reduction device 25 for a plurality of terminals. The confluence-noise-level-check unit 27 and the confluence-noise-reduction unit 28 of the confluence-noise-reduction device 25 have the configurations of Fig.1 and Fig.2, respectively. The terminal-end confluence-noise-control device 29 detects a tone

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noise-reduction unit 28 provided in the pertinent splitter unit 22 attenuates the upward signals by 15 dB. Further, the variable attenuator of the confluence-noise-reduction unit 28 provided in the two-way amplification unit 21 attenuates the upward signals by 10 dB. As a result, the upward signals are supplied to the center as signals having a predetermined signal level. Since the confluence noise is attenuated by 25 dB in total, a C/N reduction is avoided, thereby making it possible to provide a continuing service of two-way communication.

In this manner, when a terminal 23 is taken off from a branch transmission line 31 to make an open end, a noise level exhibits an increase at a confluence point of upward signals. Such an increase is detected by the confluence-noise-level-check unit 27 of the confluence-noise-reduction device 25 provided in the two-way amplification unit 21, for example, resulting in transmission of a tone signal. When detecting the tone signal, the terminals 23 boost gains of the variable amplifiers thereof to step up a transmission level of upward signals. While the upward signals are boosted, noise generated by the open-end noise source is not amplified. Such noise merely merge with the upward signals. Then, the upward signals are attenuated to bring the boosted transmission level down to the original signal level, bringing down the noise level together. This is the mechanism of how a C/N reduction can be avoided even when the confluence noise is increased.

The gain increase of the variable amplifier by the terminal-end confluence-noise-control device 29 is basically selected such as to compensate for the increase of attenuation of the variable attenuator 18. It is conceivable, however, to select the gain increase such as to compensate for various losses such as losses incurred at splitters and losses of the transmission

lines in addition to compensating for the attenuation increase. In consideration of this, it is preferable to select a possibly different gain for different terminals when the tone signal is detected.

Fig.4 is a block diagram of a relevant part of a terminal used in the confluence-noise-reduction system according to the present invention.

The configuration of Fig.4 includes a separation filter 41, a cable modem 42, a control unit 43, a variable amplifier 44, a band-pass filter 45, and a tone-detection-and-control unit 46. The control unit 43 includes a display, a keyboard, etc. The variable amplifier 44, the band-pass filter 45, and the tone-detection-and-control unit 46 together make up the terminal-end confluence-noise-control device 29 of Fig.3.

The separation filter 41 connected to a branch transmission line separates a downward signal, and supplies it to the cable modem 42. Further, the separation filter 41 sends an upward signal to the branch transmission line when the upward signal modulated by the cable modem 42 is supplied via the variable amplifier 44. As previously described, when the confluence-noise-level-check unit 27 of the confluence-noise-reduction device 25 (Fig.3) transmits a tone signal indicative of an increase of confluence noise, the band-pass filter 45 extracts this tone signal. The tone-detection-and-control unit 46 then detects the extracted tone signal, and controls the variable amplifier 44 to increase its gain. In this manner, an upward signal having a boosted transmission level is transmitted to the center.

The tone signal may prompt the gain increase of the variable amplifier 44 during a whole period while the tone signal is being transmitted. Alternatively, the tone signal may be transmitted only at such a timing as a gain is to be changed.

Alternatively, two types of tone signals may be transmitted in order to switch between a state of an increased gain and a state of a normal gain. Further, use of frequency information, on/off patterns, code information, etc., of the tone signal makes it possible to convey position information. Moreover, it is possible to include information about a signal level associated with a check of an increase in confluence noise.

Fig.5 is a block diagram of a confluence-noise-level-check unit used in a confluence-noise reduction device according to a second embodiment of the present invention.

The confluence-noise-level-check unit of Fig.5 includes a band-pass-filter/buffer-amplifier unit 51, a demodulator 52, a band-pass filter 53, a high-frequency demodulator 54, a level-check unit 55, an average-demodulation-level-storage unit 56, a noise-level-calculation unit 57, a comparison-check unit 58, a noise-reduction-control unit 59, and a subtraction unit 60. In Fig.5, solid lines indicates flow of high-frequency signals such as upward signals, and dashed lines indicate medium-frequency signals and demodulated output signals. Further, intermittently dashed lines indicate direct-current signals.

The band-pass-filter/buffer-amplifier unit 51 extracts part of an upward signal, and the demodulator 52 demodulates the extracted upward signal. The band-pass filter 53 supplies a base-band signal to the level-check unit 55 and the average-demodulation-level-storage unit 56. In the same manner as the demodulator 2 of Fig.1, the demodulator 52 may attend to coherent detection based on either a reproduced carrier wave or a delayed signal.

The average-demodulation-level-storage unit 56 may obtain an average over a predetermined time period of a base-band signal supplied from the band-

pass filter 53, and may hold the obtained average level. Alternatively, the average-demodulation-level-storage unit 56 may keep therein a fixed reference level to be used for comparison. The level-check unit 55 compares the base-band-signal level supplied from the band-pass filter 53 with the level of the average-demodulation-level-storage unit 56, and ascertains that a signal is a valid upward signal if the compared levels are close to each other.

The high-frequency demodulator 54 demodulates a high-frequency signal supplied from the band-pass-filter/buffer-amplifier unit 51. A demodulated output of the high-frequency demodulator 54 includes a signal component and a noise component, and is supplied to the subtraction unit 60. The subtraction unit 60 obtains a difference between the base-band-signal level from the level-check unit 55 and the level of the demodulated output supplied from the high-frequency demodulator 54. The obtained difference corresponds to a noise level. The noise-level-calculation unit 57 derives a noise level from the level difference provided from the subtraction unit 60.

The comparison-check unit 58 compares the noise level of the noise-level-calculation unit 57 with the level of the average-demodulation-level-storage unit 56. The comparison-check unit 58 ascertains that there is an increase in confluence noise if the noise level is greater in comparison. In this case, the comparison-check unit 58 supplies a control signal to the noise-reduction-control unit 59. In response, the noise-reduction-control unit 59 attenuates upward signals by use of a variable attenuator of a confluence-noise-reduction unit, and attends to the control of a transmission level of terminals. This portion is basically the same as the operation of the first embodiment.

Fig.6 is a block diagram of a confluence-

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noise-level-check unit used in a confluence-noise reduction device according to a third embodiment of the present invention.

The confluence-noise-level-check unit of Fig.6 includes a band-pass-filter/buffer-amplifier unit 61, a demodulator 62, a band-pass filter 63, a high-frequency switch circuit 64, a level-check unit 65, a high-frequency demodulator 66, a noise-detection unit 67, a noise-level-comparison-check unit 68, a noise-reduction-control unit 69, a noise-level-check unit 70, a subtraction unit 71, and a detection-level-storage unit 72. In Fig.6, solid lines indicates flow of high-frequency signals such as upward signals, and dashed lines indicate medium-frequency signals and demodulated output signals. Further, intermittently dashed lines indicate direct-current signals.

The band-pass-filter/buffer-amplifier unit 61, the demodulator 62, the band-pass filter 63, the high-frequency switch circuit 64, the level-check unit 65, and the noise-detection unit 67 have the same configurations and operations as those of corresponding elements shown in Fig.1. The noise-detection unit 67 receives a high-frequency signal from the band-pass-filter/buffer-amplifier unit 61 via the high-frequency switch circuit 64 when the high-frequency switch circuit 64 is switched on in response to a situation where noises are present with no valid upward signals. The noise-detection unit 67 attends to high-frequency detection of noise components that are observed during a period of no signal transmission. The high-frequency demodulator 66 attends to high-frequency detection at all the time regardless of whether there are signal components or noise components.

The noise-level-check unit 70 supplies an output of the noise-detection unit 67 to the subtraction unit 71, and supplies a noise-level signal to the noise-level-comparison-check unit 68 where the

noise-level signal is indicative of a checked noise level. The subtraction unit 71 obtains a difference between the output signal level of the high-frequency demodulator 66 and the output noise level of the noise-detection unit 67 supplied from the noise-level-check unit 70. An obtained difference corresponds to a received signal level less a noise level, thereby representing a level of a signal component. This is regarded as a detected signal level, which is then held by the detection-level-storage unit 72. The detected signal level held by the detection-level-storage unit 72 is supplied to the noise-level-comparison-check unit 68.

The noise-level-comparison-check unit 68 compares the noise level of the noise-level-check unit 70 with the detected signal level of the detection-level-storage unit 72. When the noise level is greater in comparison, the noise-level-comparison-check unit 68 ascertains that there is an increase in confluence noise, and supplies a control signal to the noise-reduction-control unit 69. The noise-reduction-control unit 69 attends to the same control as in the previous embodiments.

Fig.7 is an illustrative drawing for explaining the level-check operation of the present invention. What is shown in Fig.7 corresponds to the operations of the level-check units 5, 55, and 65 shown in Figs.1, 5, and 6, respectively.

High-frequency-band signals Rf_1 through Rf_N are transmitted as upward signals by using a frequency band ranging from 10 MHz to 55 MHz. In Fig.7, the band-pass-filter/buffer-amplifier unit 1, 51, or 61 is shown as a filter 75. The filter 75 may have a frequency characteristic allowing passage of high-frequency-band signals Rf_1 through Rf_N , or have a pass-band ranging from 10 MHz to 55 MHz. Alternatively, the filter 75 may have a high-pass-filter characteristic

that allows passage of frequencies higher than or equal to Rf_1 , or may have a low-pass-filter characteristic that allows passage of frequencies lower than or equal to Rf_N . Alternatively, the filter 75 may have a frequency characteristic that allows passage of some of the high-frequency-band signals Rf_1 through Rf_N . Where only one terminal is connected to the confluence-noise-reduction device and only one frequency is used, the filter 75 may have a frequency characteristic that allows passage of that particular frequency.

The demodulator 2, 52, or 62 is shown as a demodulator 76 in Fig.7. Low-frequency-band signals f_1 through f_N are supplied from the demodulator 76 via the band-pass filter 3, 53, or 63. A check is made on a level of the low-frequency-band signals f_1 through f_N . The low-frequency-band signals f_1 through f_N may have a frequency range between 10 kHz and 10 MHz. Depending on the frequency characteristic of the filter 75, only some of the low-frequency-band signals f_1 through f_N may be included.

For the sake of simplicity, in Fig.7, the low-frequency-band signals f_1 through f_N are shown as having the same signal level. In reality, however, each signal has a different signal level generally because of a difference in transmission-line losses or the like. When amplification control is put in place such as to control a signal level of each frequency band at the same signal level, however, the low-frequency-band signals f_1 through f_N will have the same signal level as shown in Fig.7. Each signal is transmitted as a burst signal. In the configuration of Fig.1 or Fig.5, therefore, the average-demodulation-level-storage unit 6 or 56 obtains an average over a predetermined time period, and holds the obtained average. Since upward signals are burst signals, at least one of the noise level or the signal level is stored and used in a level comparison where the noise

level and the signal level are detected during different time period.

Fig.8 is an illustrative drawing for explaining the level-check operation of the present invention. Fig.8 shows an operation more complex than that shown in Fig.7. The operation of Fig.8 can provide more accurate level detection.

In Fig.8, band-pass filters 81_1 through 81_N are provided with respect to the high-frequency-band signals Rf_1 through Rf_N , respectively. The band-pass filters 81_1 through 81_N correspond to the band-pass-filter/buffer-amplifier unit 1, 51, or 61. Further, the demodulator 2, 52, or 62 corresponds to a set of demodulator circuits 82_1 through 82_N , which are provided to correspond to the high-frequency-band signals Rf_1 through Rf_N , respectively. Demodulated signals output from the demodulator circuits 82_1 through 82_N ultimately become the low-frequency-band signals f_1 through f_N , respectively, which are subjected to a level comparison.

Fig.9 is an illustrative drawing for explaining the operation of controlling upward signals according to the present invention. Fig.9 shows a relevant portion of the terminal-end confluence-noise-reduction device.

A configuration of Fig.9 includes a high-pass filter 91, a low-pass filter 92, a high-pass filter 93, a low-pass filter 94, a variable amplifier 95, a band-pass filter 96, and a tone-detection unit 97. The high-pass filters 91 and 93 allow downward signals to pass therethrough, and the low-pass filters 92 and 94 allow upward signals to pass therethrough. The band-pass filter 96 and the tone-detection unit 97 together make up a tone-signal-detection mechanism.

A downward signal transmitted through a branch-transmission line passes through the high-pass filter 91, and the band-pass filter 96 extracts a pilot

The upward signals from a terminal to the center are supplied from a cable modem to the variable amplifier 95 via the low-pass filter 94, and, then, are sent to the center via the low-pass filter 92. During a normal operation, the gain of the variable amplifier 95 may be set to 1. When confluence noise is increased to result in the tone signal being inserted into a downward signal, the tone-detection unit 97 detects the tone signal, and boosts the gain of the variable amplifier 95. A C/N ratio of the upward signals are improved in this manner when the upward signals are transmitted to the center. As previously described, a variable attenuator of a confluence-noise-reduction unit attenuates the upward signals by an amount commensurate with the gain increase of the variable amplifier 95, thereby transmitting the upward signal to the center as signals having a predetermined signal level. As the upward signals are attenuated, noises are also attenuated, thereby avoiding a reduction of the C/N ratio.

Fig.10 is a block diagram of an

upward-signal-attenuation unit used in a confluence-noise-reduction system according to another embodiment of the present invention. What is shown in Fig.10 corresponds to a confluence-noise-reduction unit. Fig.11 is a block diagram of an upward-signal-amplification unit used in a confluence-noise-reduction system in combination with the unit of Fig.10. What is shown in Fig.11 corresponds to a terminal-end confluence-noise-control device.

A configuration of Fig.10 includes a high-pass filter 101, a low-pass filter 102, a fixed attenuator 103, and a low-pass filter 104. Downward signals pass through the high-pass filter 101, and upward signals pass through the low-pass filter 102, the fixed attenuator 103, and the low-pass filter 104. A configuration of Fig.11 includes a high-pass filter 111, a low-pass filter 112, a narrow-band amplifier 113, and a low-pass filter 114. Downward signals pass through the high-pass filter 111, and upward signals pass through the low-pass filter 112, the narrow-band amplifier 113, and the low-pass filter 114.

The fixed attenuator 103 may be provided in each of the two-way amplification unit 21 and the splitter units 22 shown in Fig.3. The fixed attenuator 103 provided in the two-way amplification unit 21 may be set to an attenuation of 10 dB, and the fixed attenuator 103 provided in the splitter units 22 may be set to an attenuation of 15 dB. The narrow-band amplifier 113 provided in a terminal is controlled so as to boost upward signals by 25 dB. As a result, the upward signals having a level thereof boosted by 25 dB are transmitted from the terminal to a branch-transmission line, and are attenuated by 15 dB in the splitter unit with an additional attenuation of 10 dB being introduced in the two-way amplification unit.

In this embodiment, attenuation is fixed in advance by use of the fixed attenuator 103, and a gain

increase is introduced only within a frequency band selected in advance by use of the narrow-band amplifier 113. Such a configuration is flexible in that the attenuation and gains are selected by taking into account losses at various portions of the system. While the upward signals are attenuated after amplification so as to return to an original signal level, noises are attenuated by 25 dB, for example, thereby avoiding a reduction in the C/N ratio.

Fig.12 is an illustrative drawing of a confluence-noise-reduction system according to another embodiment of the present invention.

Fig.12 shows a two-way amplification unit 121, splitter units 122₁ through 122₃, terminals 123₁ through 123₃, two-way amplifiers 124₁ and 124₂, a confluence-noise-reduction device 125, terminal-end confluence-noise-control devices 126₁ and 126₂, a confluence-noise-level-check unit 127, a confluence-noise-reduction unit 128, and a terminator 130.

The system of this embodiment may be typically used within one building or within a complex of house units. The two-way amplification unit 121 is provided indoor, and the terminator 130 is connected to an open-end node of the splitter units 122₁ through 122₃. The splitter unit 122₃ splits signals at a power ratio of 1 to N.

In this configuration, let us denote splitting losses at the splitter units 122₁, 122₂, and 122₃ as x dB, y dB, and z dB, respectively. Further, attenuation of the confluence-noise-reduction unit 128 is assumed to be 15 dB. In such a case, a gain increase of a variable amplifier provided in the terminal-end confluence-noise-control device 126₁ of the terminal 123₁ is set to (15 + x) dB. A gain increase of a variable amplifier provided in the terminal-end confluence-noise-control device 126₂ of the terminal 123₂ is set to (15 + x + y + z) dB.

An upward signal transmitted from the terminal-end confluence-noise-control device 126₁ is amplified by $(15 + x)$ dB. This upward signal is attenuated in the splitter unit 122₁ by x dB, and is further attenuated in the confluence-noise-reduction unit 128 by 15 dB before being supplied to the center. An upward signal transmitted from the terminal-end confluence-noise-control device 126₂ is amplified by $(15 + x + y + z)$ dB. This upward signal is attenuated in the splitter units 122₃, 122₂, and 122₁ by z dB, y dB, and x dB, respectively, and is further attenuated in the confluence-noise-reduction unit 128 by 15 dB before being supplied to the center.

In this manner, these upward signals are supplied from the two-way amplifier 124₁ to the center as signals having a predetermined signal level. Because of the attenuation by 15 dB, noises that are not amplified at noise sources are attenuated by 15 dB. The present invention thus can avoid a reduction of the C/N ratio in cases such as when confluence noise is increased by an open end of a transmission line.

In a configuration where the main-transmission line is connected to a splitter via an outdoor two-way amplification unit, an attenuation by 10 dB may be provided in the confluence-noise-reduction device provided in the two-way amplification unit. In this case, a gain increase may be set to $(10 + \alpha)$ dB where α dB is a transmission loss.

Fig.13 is a block diagram of a noise-source searching unit according to the present invention.

The noise-source searching unit of Fig.13 includes a high-pass filter 131, a low-pass filter 132, an amplifier 133, an amplifier 134, a band-pass filter 135, a modulation unit 136, a high-pass filter 137, a variable attenuator 138, a low-pass filter 139, a confluence-noise-level-check unit 140, a band-pass filter 141, and a modulation unit 142. The high-pass

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on the system.

As described above, the present invention attenuates the upward signals by an amount that compensates for a gain increase of the upward signals. Noises from noise sources are attenuated without being amplified, thereby resulting in the prevention of C/N degradation. It is conceivable to cut off the upward signals in response to the detection of an increase in confluence noise. The upward signals observed at splitters or two-way amplifiers, however, are a mixture of upward signals coming from various terminals, so that cutting off of such upward signals means less services to the terminals. The present invention can prevent confluence noises from degrading a C/N ratio without cutting off the upward signals, thereby providing better services in two-way CATV system.

Further, the tone signal may be configured to include positional information, noise-level information, etc., when the tone signal is transmitted in response to an increase of confluence noise. In such a case, identifying the tone signal can help to search for a cause of the noise increase. This makes it easier to maintain and operate a two-way CATV system.

Further, the present invention is not limited to these embodiments, but various variations and modifications may be made without departing from the scope of the present invention.

The present application is based on Japanese priority application No. 11-159439 filed on June 7, 1999, with the Japanese Patent Office, the entire contents of which are hereby incorporated by reference.

0959417-060700

WHAT IS CLAIMED IS

1. A system for reducing noise in a signal line, through which upward signals and downward signals are transmitted between a center and terminals, comprising:

a noise-reduction device, provided between the center and the terminals, which attenuates the upward signals by an increased amount when a noise increase regarding the upward signals is detected on the signal line; and

a noise-control device, provided at terminals, which boosts a transmission level of the upward signals by an amount compensating for the attenuation of the upward signals by said noise-reduction device.

2. The system as claimed in claim 1, wherein said noise-reduction device includes:

a noise-level-check unit which makes a comparison between a signal component and a noise component that are obtained from the signal line, and detects a noise increase based on the comparison; and

a noise-reduction unit which includes an attenuator that attenuates the upward signals by the increased amount if said noise-level-check unit detects the noise increase, and which transmits a tone signal via the downward signals if said noise-level-check unit detects the noise increase.

3. The system as claimed in claim 2, wherein said noise-control device includes:

a tone-detection unit which detects the tone signal; and

a variable amplifier which boosts amplification of the upward signals by an amount compensating for the attenuation of the upward signals by said attenuator.

4. The system as claimed in claim 1, wherein one or more noise-reduction devices including said noise-reduction device are provided in one or more of a two-way-amplification unit and splitter units provided between the center and the terminals.

5. The system as claimed in claim 4, wherein said noise-control device boosts the transmission level of the upward signals by an amount compensating for a total attenuation of the upward signals by all of said one or more noise-reduction devices.

6. The system as claimed in claim 1, wherein said noise-reduction device includes:

a unit which obtains a level of a signal component demodulated through coherent detection of the upward signals;

a unit which obtains a level of a noise component demodulated through detection of noises

observed on the signal line during a time period when no signal component is present; and

a check unit which makes a comparison between the level of the signal component and the level of the noise component, and detects a noise increase based on the comparison.

7. The system as claimed in claim 1, wherein said noise-reduction device includes:

a unit which obtains a level of a signal component demodulated through coherent detection of the upward signals;

a unit which obtains a level of signal and noise components demodulated through detection of a high-frequency signal included within a frequency range of the upward signals;

a subtraction unit which obtains a noise level as a difference between the level of the signal component and the level of the signal and noise components; and

a check unit which compares the noise level with one of a reference level and the level of the signal component, and detects a noise increase based on the comparison.

8. The system as claimed in claim 1, wherein said noise-reduction device includes:

a unit which obtains a level of a signal component demodulated through coherent detection of the upward signals;

a unit which obtains a level of a noise

component demodulated through detection of noises observed on the signal line during a time period that is identified as a noise period when the level of the signal component is below a predetermine threshold;

a unit which obtains a level of signal and noise components demodulated through detection of a high-frequency signal included within a frequency range of the upward signals;

a subtraction unit which obtains a signal level as a difference between the level of the noise component and the level of the signal and noise components; and

a check unit which compares the signal level with the level of the noise component, and detects a noise increase based on the comparison.

9. A device for reducing noise in a communication system having a signal line, through which upward signals and downward signals are transmitted, comprising:

a noise-level-check unit which makes a comparison between a signal component and a noise component that are obtained from a signal line, and detects a noise increase regarding the upward signals based on the comparison; and

a noise-reduction unit which attenuates the upward signals by an increased amount and transmits a tone signal via downward signals if said noise-level-check unit detects the noise increase.

10. The device as claimed in claim 9, wherein

a unit which obtains a level of a signal component demodulated through coherent detection of the upward signals;

a check unit which makes a comparison between the level of the signal component and the level of the noise component, and detects a noise increase based on the comparison.

a unit which obtains a level of a signal component demodulated through coherent detection of the upward signals;

a subtraction unit which obtains a noise level as a difference between the level of the signal component and the level of the signal and noise components; and

a check unit which compares the noise level with one of a reference level and the level of the signal component, and detects a noise increase based on the comparison.

12. The device as claimed in claim 9, wherein said noise-level-check unit includes:

a unit which obtains a level of a signal component demodulated through coherent detection of the upward signals;

a unit which obtains a level of a noise component demodulated through detection of noises observed on the signal line during a time period that is identified as a noise period when the level of the signal component is below a predetermine threshold;

a unit which obtains a level of signal and noise components demodulated through detection of a high-frequency signal included within a frequency range of the upward signals;

a subtraction unit which obtains a signal level as a difference between the level of the noise component and the level of the signal and noise components; and

a check unit which compares the signal level with the level of the noise component, and detects a noise increase based on the comparison.

13. The device as claimed in claim 9, wherein said noise-reduction unit includes:

filters which separate downward signals and the upward signals from each other;

a variable attenuator which attenuates the upward signals by the increased amount in response to a control signal from said noise-level-check unit indicating a detection of the noise increase; and

a tone-signal-transmission unit which inserts the tone signal into the downward signals in response to the control signal indicating the detection of the noise increase.

14. The device as claimed in claim 9, wherein said noise-reduction unit transmits a tone signal via the upward signals if said noise-level-check unit detects the noise increase.

15. The device as claimed in claim 14, wherein said noise-reduction unit transmits the tone signal by including positional information in the tone signal.

[illegible][illegible]

FIG. 1

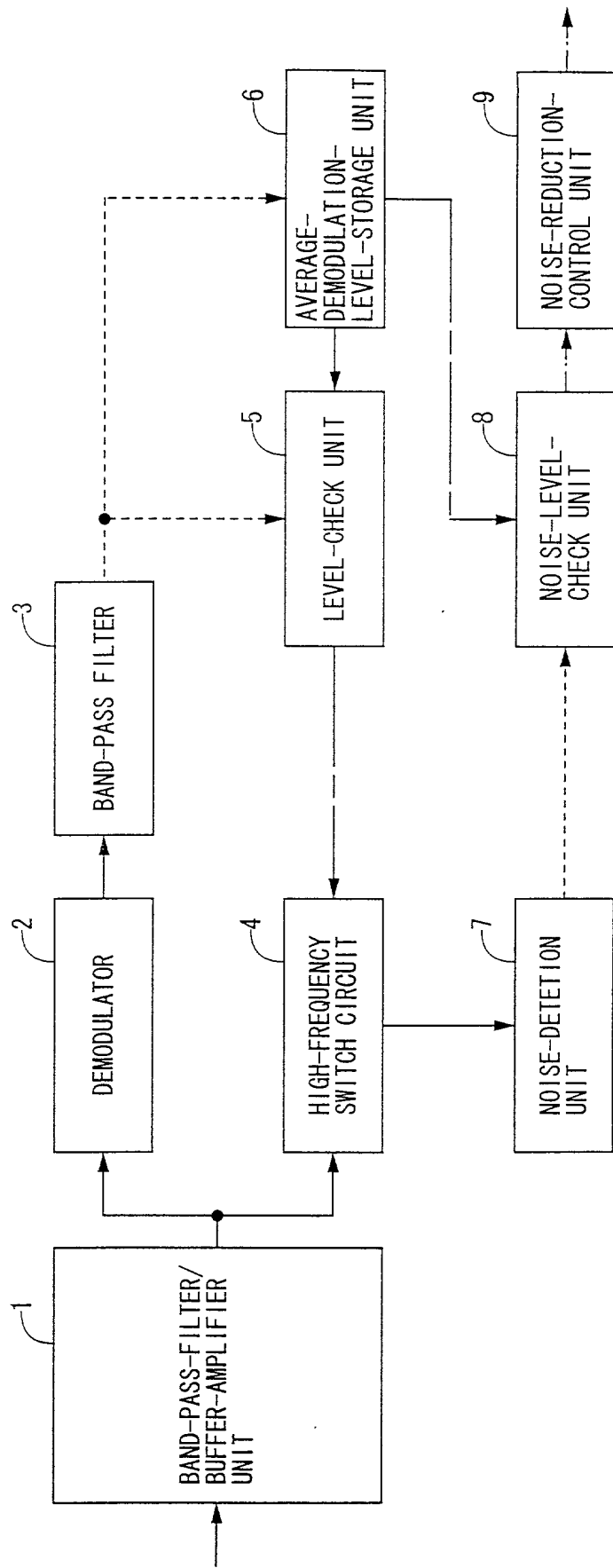


FIG. 2

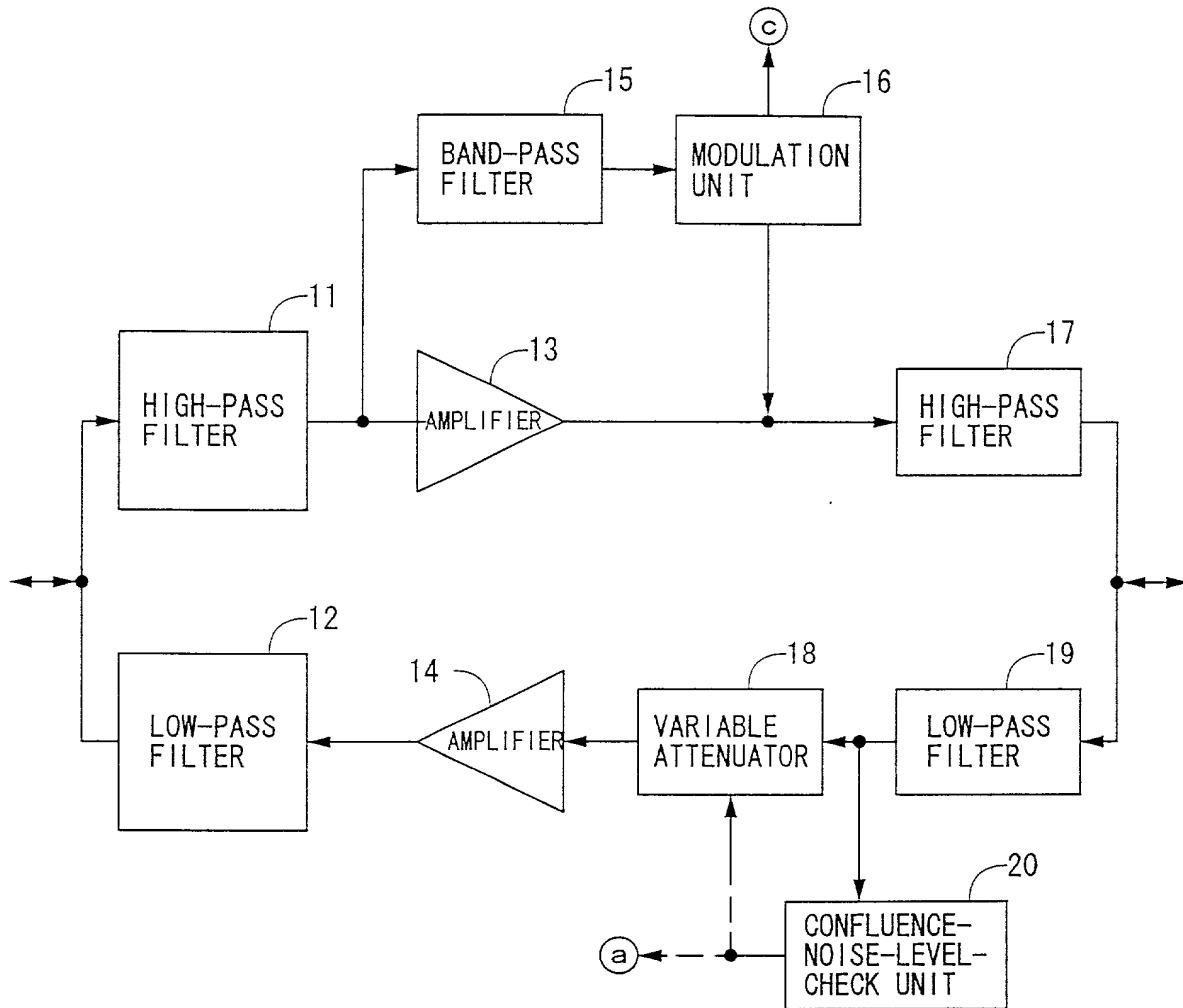


FIG. 4

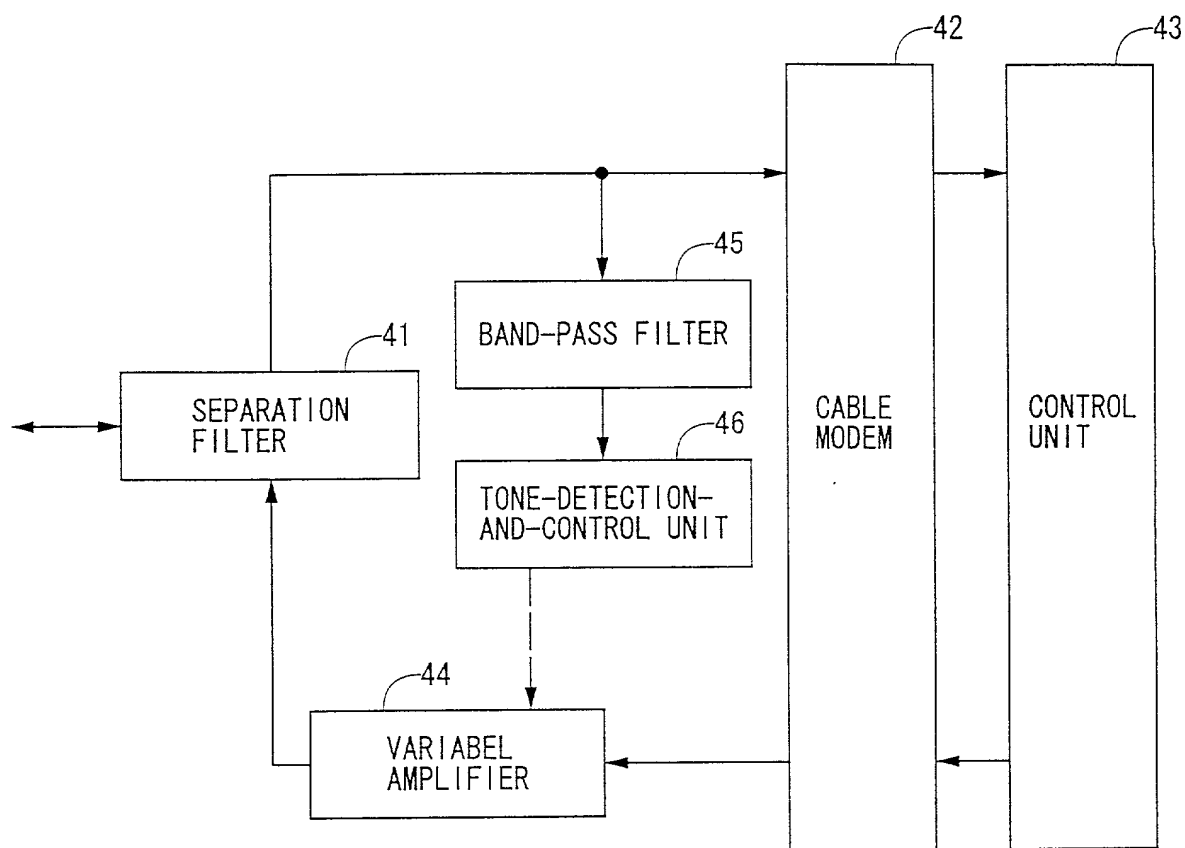


FIG. 5

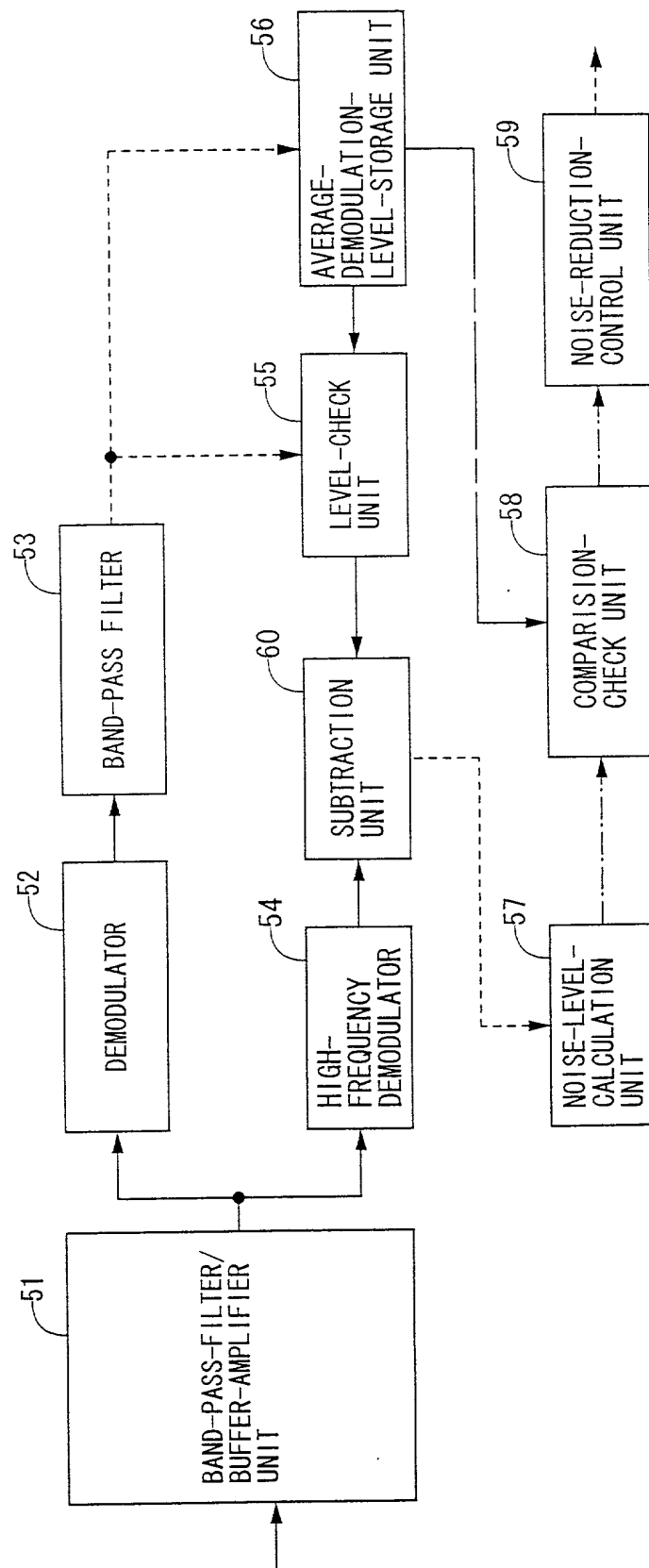


FIG. 6

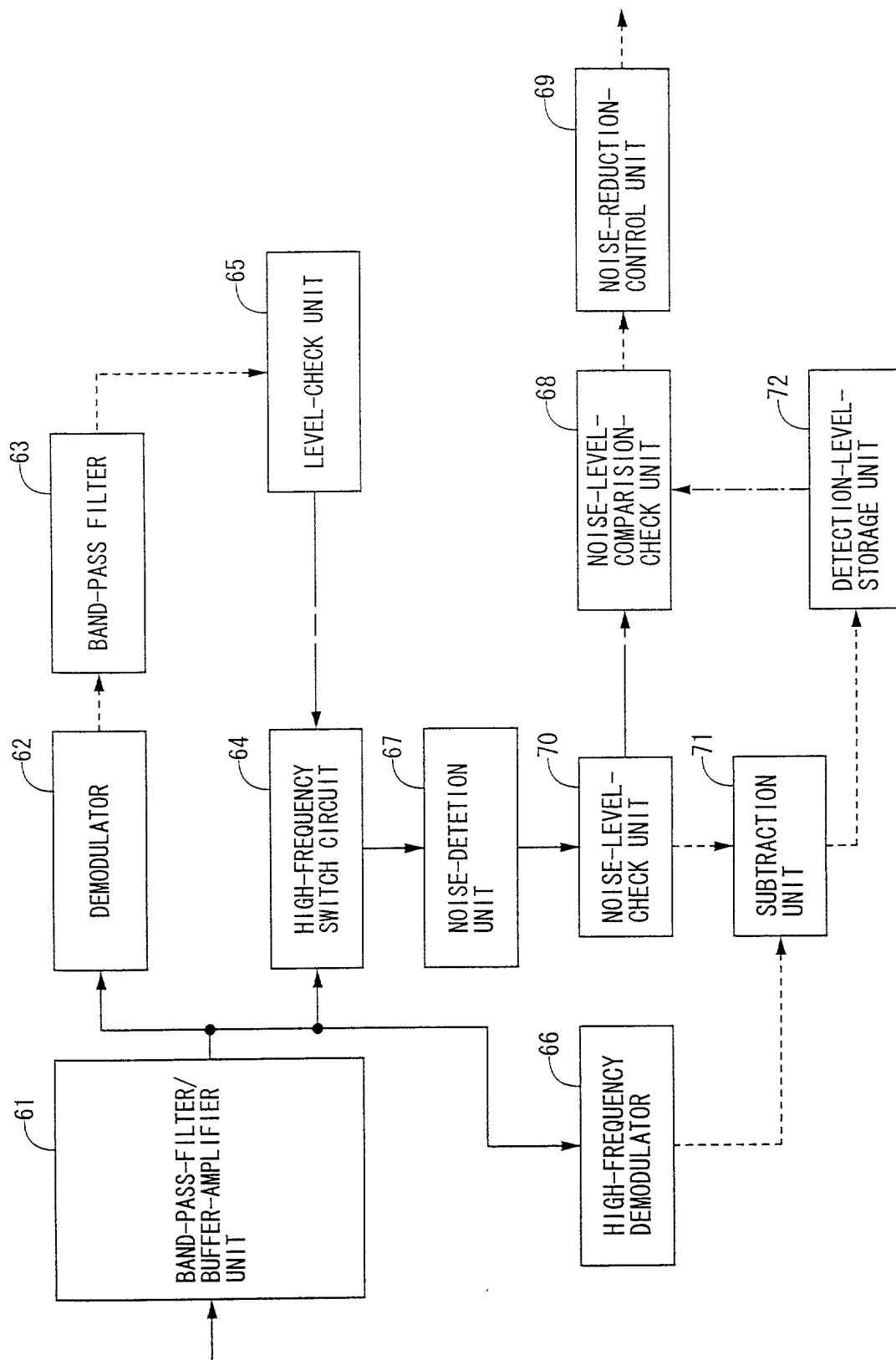
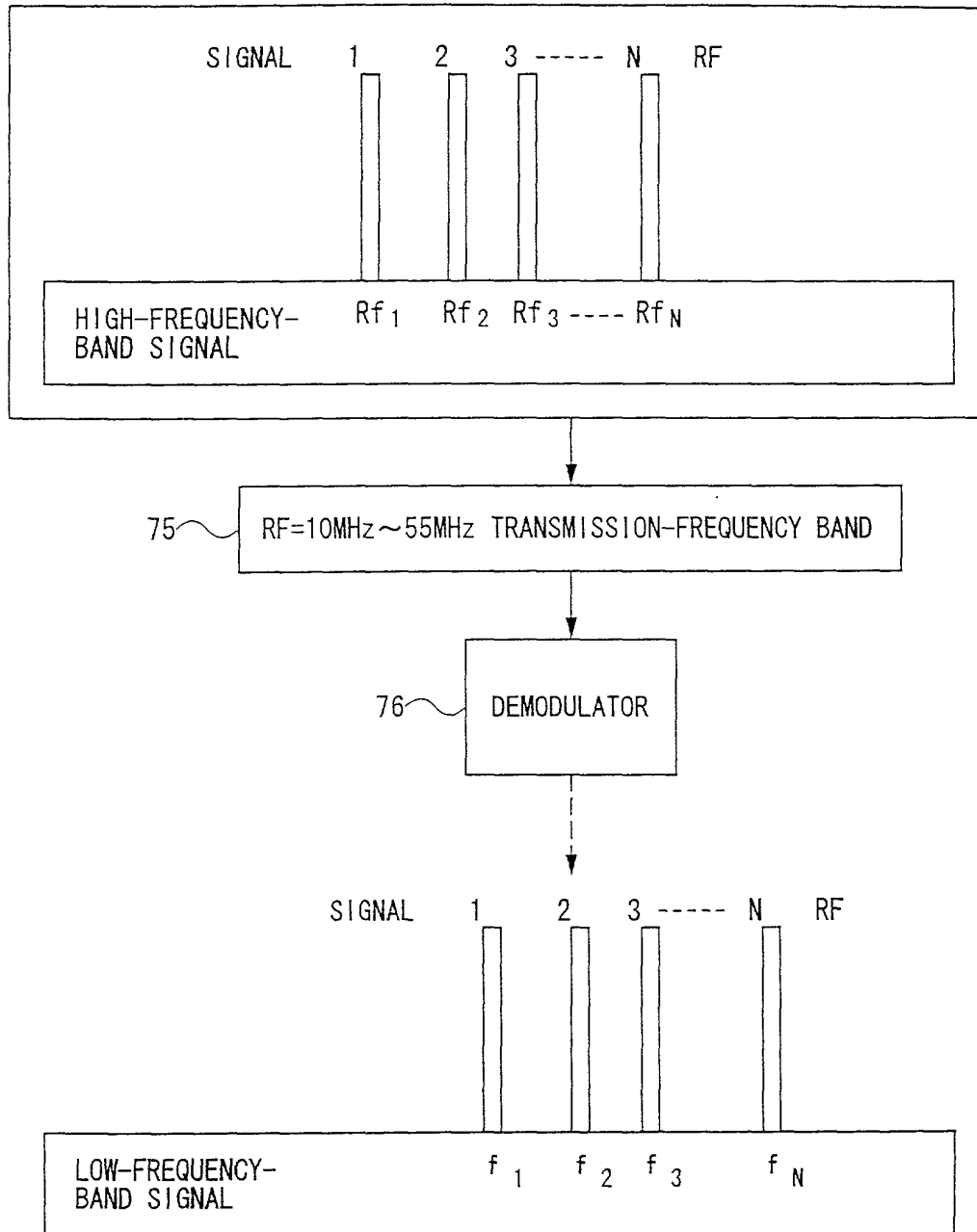
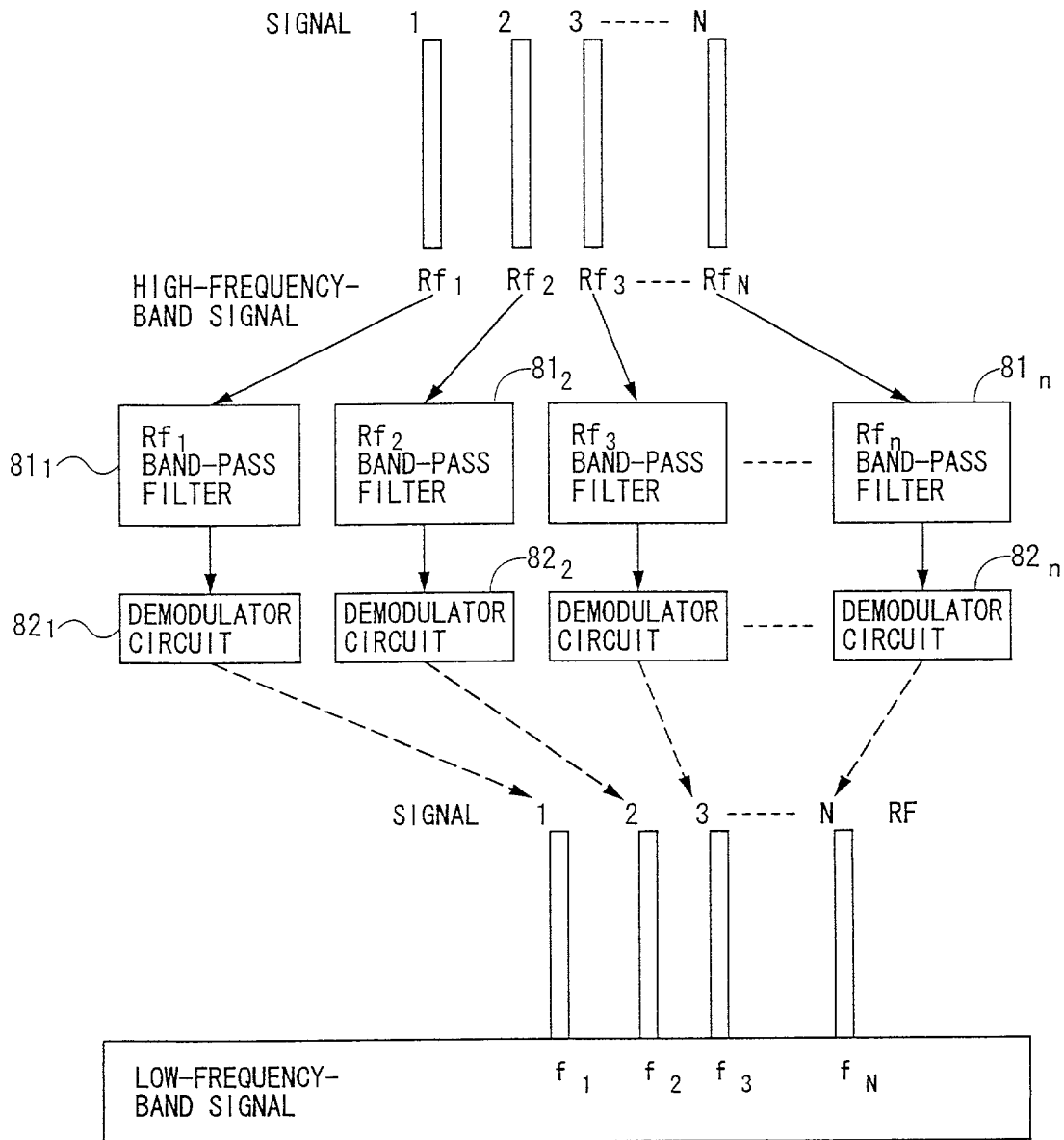


FIG. 7



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FIG. 8



F I G. 9

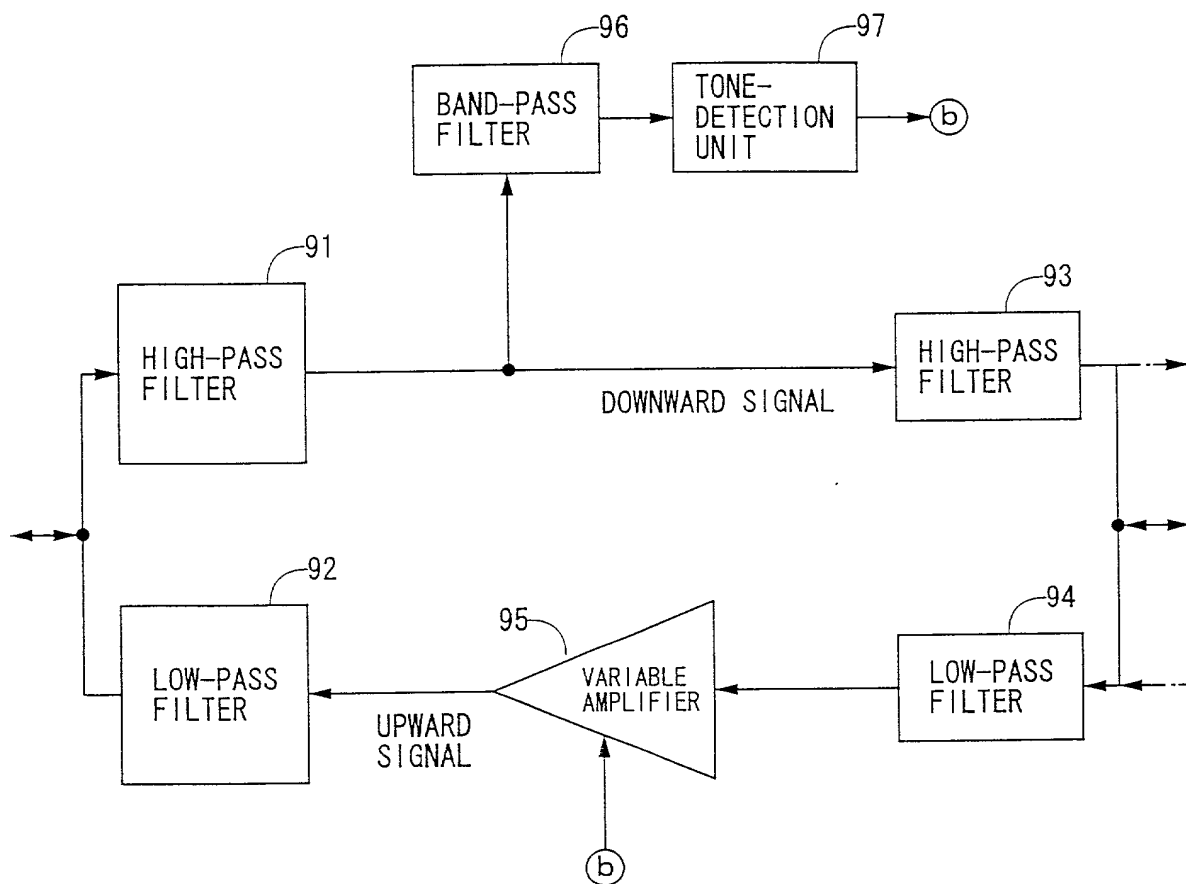
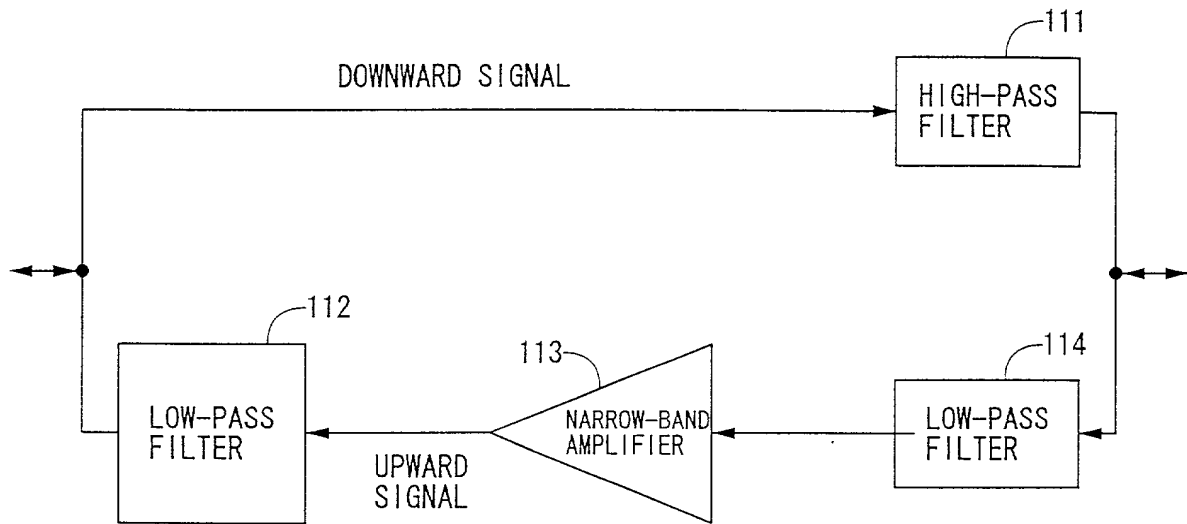


FIG. 11



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FIG. 12

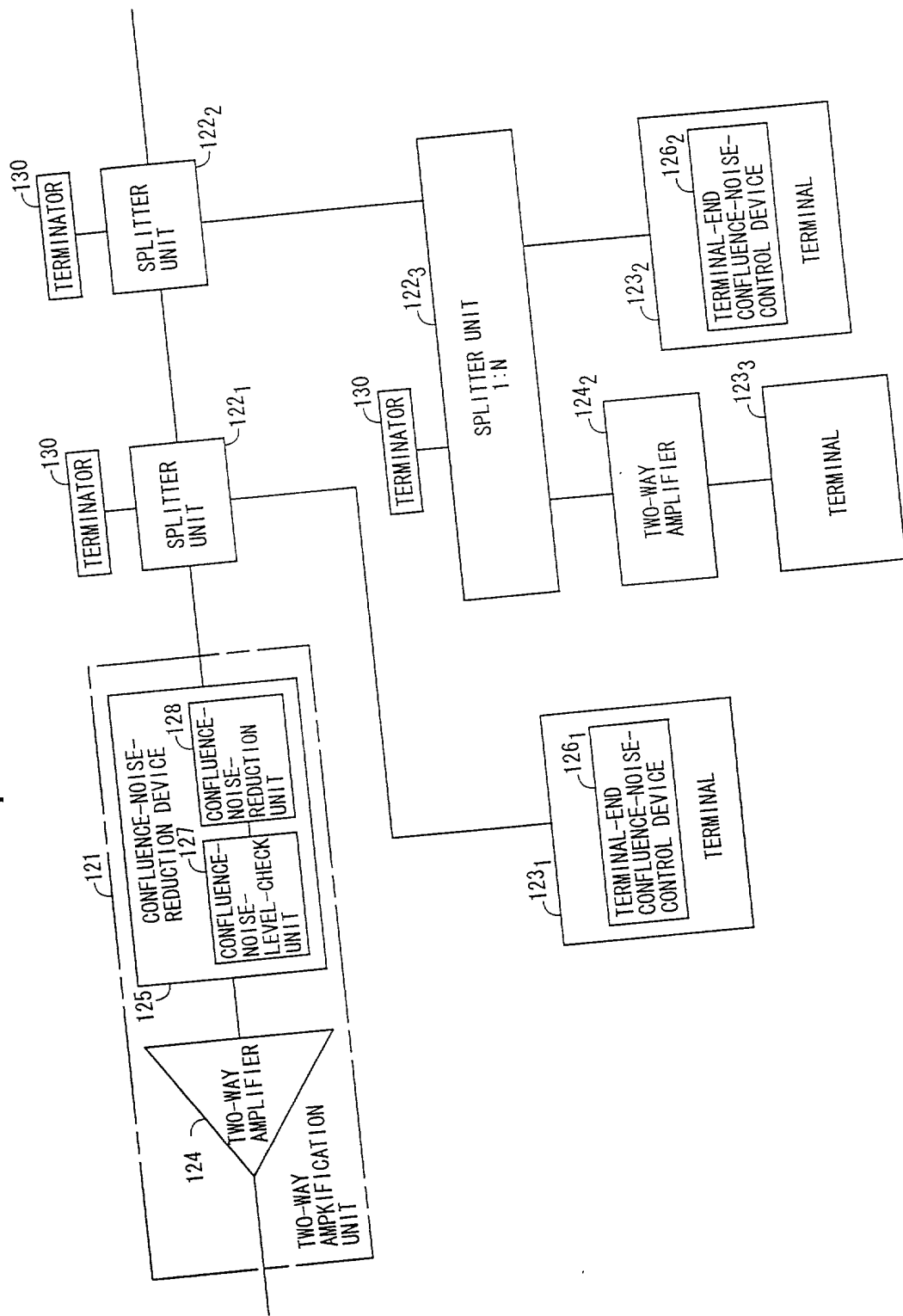


FIG. 13

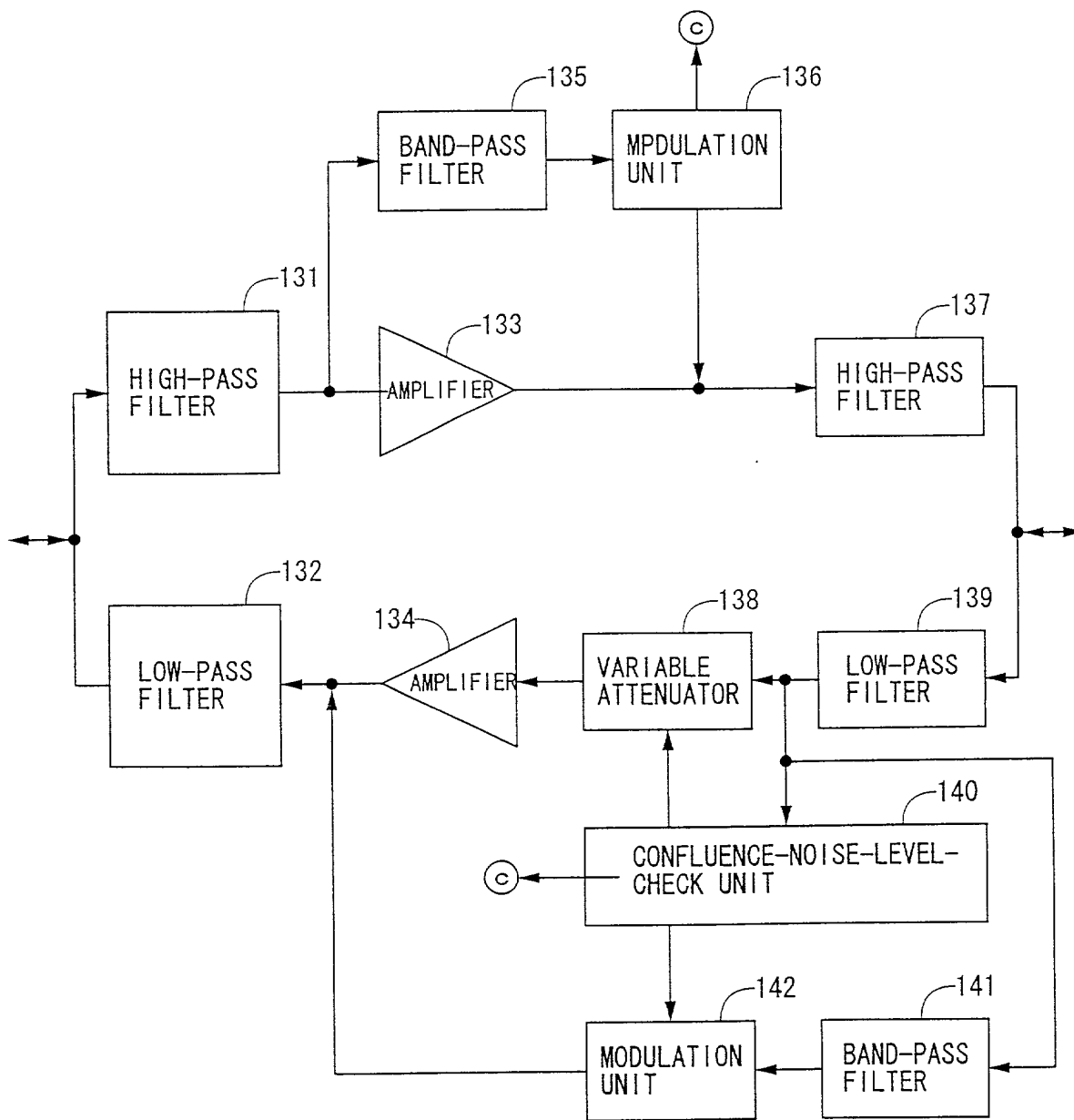
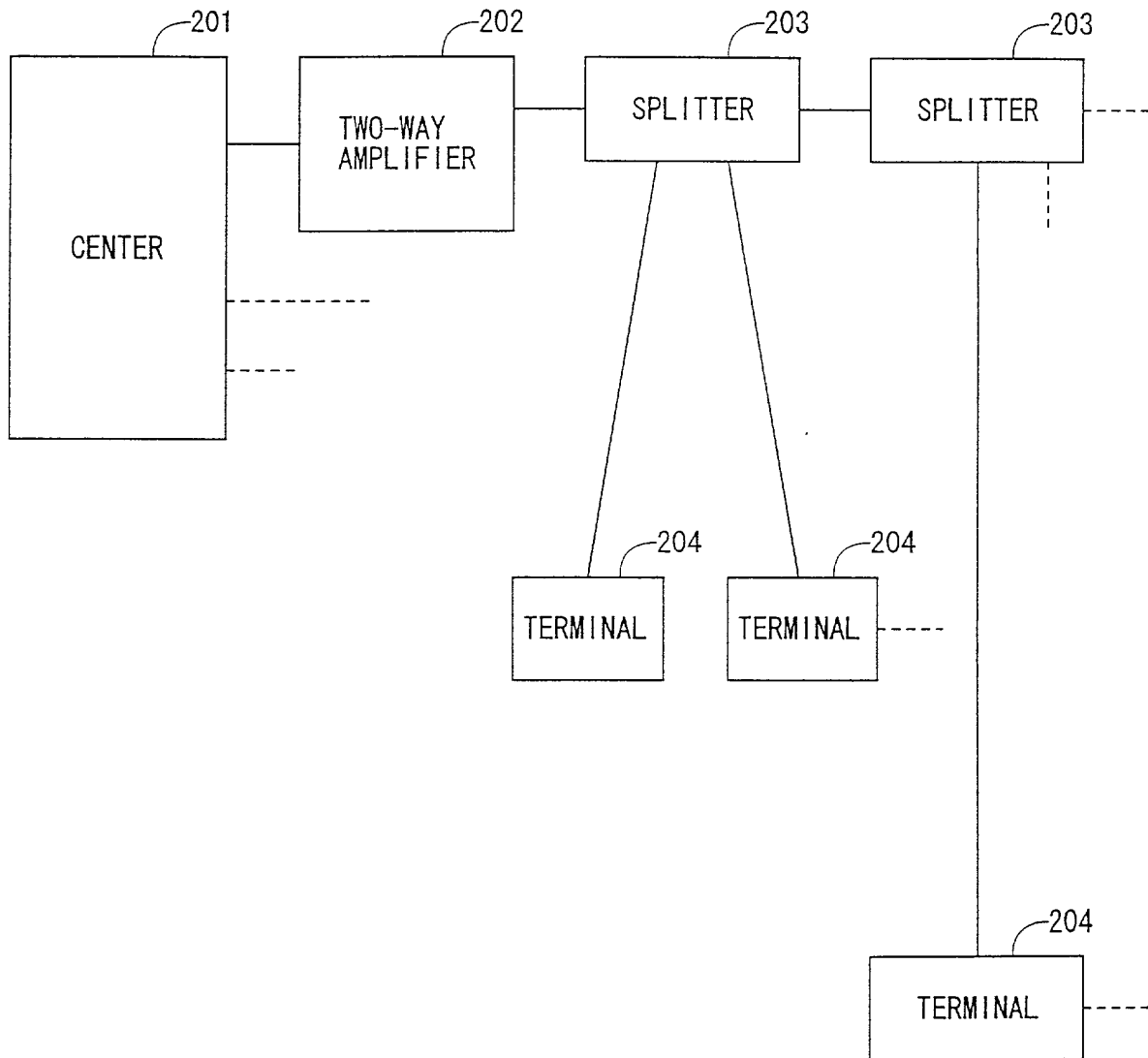


FIG. 14



Declaration and Power of Attorney For Patent Application**特許出願宣言書及び委任状****Japanese Language Declaration****日本語宣言書**

下記の氏名の発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that:

私の住所、私書箱、国籍は下記の私の氏名の後に記載された通りです。

My residence, post office address and citizenship are as stated next to my name.

下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者（下記の氏名が一つの場合）もしくは最初かつ共同発明者であると（下記の名称が複数の場合）信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

DEVICE AND SYSTEM FOR REDUCING

CONFLUENCE NOISE

上記発明の明細書（下記の欄でx印がついていない場合は、本書に添付）は、

the specification of which is attached hereto unless the following box is checked:

☐ 月 日に提出され、米国出願番号または特許協定条約国際出願番号を _____ とし、
(該当する場合) _____ に訂正されました。

☐ was filed on _____
as United States Application Number or
PCT International Application Number
_____ and was amended on
_____ (if applicable).

私は、特許請求範囲を含む上記訂正後の明細書を検討し、内容を理解していることをここに表明します。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第37編第1条56項に定義されるとおり、特許資格の有無について重要な情報を開示する義務があることを認めます。

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

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私は、米国法典第35編119条(a)-(d)項又は365条(b)項に基づき下記の、米国外の国の少なくとも一カ国を指定している特許協力条約365(a)項に基づく国際出願、又は外国での特許出願もしくは発明者証の出願についての外国優先権をここに主張するとともに、優先権を主張している、本出願の前に出願された特許または発明者証の外国出願を以下に、枠内をマークすることで、示しています。

Prior Foreign Application(s)

外国での先行出願 Pat. Appln. No. 11-159439	Japan
(Number) (番号)	(Country) (国名)
(Number) (番号)	(Country) (国名)

I hereby claim foreign priority under Title 35, United States Code, Section 119 (a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Priority Not Claimed
優先権主張なし

7/June/1999
(Day/Month/Year Filed)
(出願年月日)

(Day/Month/Year Filed)
(出願年月日)

☐

☐

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(Application No.) (出願番号)	(Filing Date) (出願日)
-----------------------------	------------------------

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

(Application No.) (出願番号)	(Filing Date) (出願日)
-----------------------------	------------------------

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(Application No.) (出願番号)	(Filing Date) (出願日)
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(Status: Patented, Pending, Abandoned) (現況: 特許許可済、係属中、放棄済)

(Application No.) (出願番号)	(Filing Date) (出願日)
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(Status: Patented, Pending, Abandoned) (現況: 特許許可済、係属中、放棄済)

私は、私自身の知識に基づいて本宣言書中で私が行なう表明が真実であり、かつ私の入手した情報と私の信じていることに基づき表明が全て真実であると信じていること、さらに故意になされた虚偽の表明及びそれと同等の行為は米国法典第18編第1001条に基づき、罰金または拘禁、もしくはその両方により処罰されること、そしてそのような故意による虚偽の声明を行なえば、出願した、又は既に許可された特許の有効性が失われることを認識し、よってここに上記のごとく宣誓を致します。

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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委任状: 私は下記の発明者として、本出願に関する一切の手続きを米特許商標局に対して遂行する弁理士または代理人として、下記の者を指名いたします。(弁護士、または代理人の氏名及び登録番号を明記のこと)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith (list name and registration number)

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(Supply similar information and signature for third and subsequent joint inventors.)

THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of: **Shigefumi MASUDA et al.**

Filed: : **Concurrently herewith**

For : **DEVICE AND SYSTEM FOR REDUCING CONFLUENCE NOISE**

Serial No.: **Concurrently herewith**

June 7, 2000

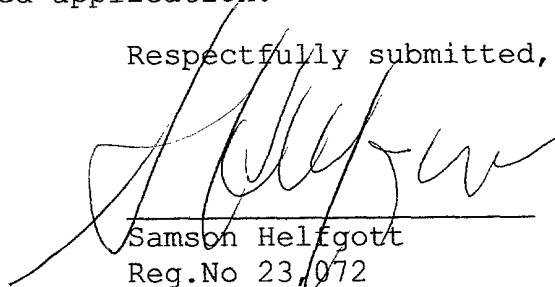
Assistant Commissioner of Patents
Washington, D.C. 20231

SUB-POWER OF ATTORNEY

S I R:

I, Samson Helfgott, Reg. No. 23,072 attorney of record herein, do hereby grant a sub-power of attorney to Linda S. Chan, Reg. No. 42,400, Jacqueline M. Steady, Reg. No., 44,354 and Harris A. Wolin, Reg. No. 39,432 to act and sign in my behalf in the above-referenced application.

Respectfully submitted,



Samson Helfgott
Reg.No 23,072

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On: June 7, 2000
By: Lydia Gonzalez
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